AEGIS

Loss Control

Turbine Lubricating Oil Systems

White Paper

Operation & Maintenance Considerations
An Insurer's Loss Control Perspective

Lubricating Oil Systems

Abstract
This paper outlines proactive operating, maintenance, training and record-keeping practices to ensure lubricating oil system readiness and reliability and prevent catastrophic failure and ensuing losses.

Introduction
The function of the turbine-generator lubricating oil system is to provide lubrication and cooling oil to the power train equipment. Failure to maintain, operate and test the system properly could result in catastrophic failure and serious consequences for both rotating equipment and personnel.

Analysis of data gathered by AEGIS reveals that turbine-generator lubricating oil loss events and associated lost revenue due to business interruption are key contributors to probable maximum loss events. AEGIS, like the industry, has learned to be cautious in dealing with these preventable occurrences. This paper discusses a number of proactive practices employed by AEGIS members to ensure lubricating oil system readiness and reliability. This paper does not discuss environmental, health and safety concerns or fire protection measures.

Additional uses of the lubricating oil system may include:

- Oil for generator hydrogen seal oil system
- Control oil for valve actuation where a separate control oil system is not provided
- Lift oil for combustion turbine, steam turbine and generator bearings
- Oil to self-shifting and synchronizing clutches

The lubricating oil system is often complex in design, with varying degrees of instrumentation and built-in automation. Irrespective of system complexity, the control elements provide oil to the system components within certain desired parameters, such as proper temperature, adequate pressure, design flow, etc.

System Components

The lubricating oil system consists of the following major subsystems:

1. **Storage system:** This subsystem may consist of a storage tank and heaters, vapor extractors and instrumentation to monitor level, temperature, etc. The primary function of this system is to provide a storage space for the bulk quantity of oil.

2. **Forwarding system:** This subsystem typically consists of redundant ac-motor AC motor-driven main bearing oil pumps, strainers, check valves and accumulators. Other configurations may include a turbine shaft-driven or steam-driven gear oil pump. The system supplies pressurized oil to the system components at design conditions.

3. **Conditioning system:** This subsystem provides clean oil at an appropriate temperature to the various system components and typically consists of redundant coolers and filters.

4. **Instrumentation and control equipment:** These components monitor and regulate oil temperature, pressure and flow, and consist of gauges, sensing elements and transmitters, temperature control valves, pressure limiting valves, etc.

5. **Emergency oil forwarding system:** This subsystem acts as a backup lubricating oil system for use under emergency operating conditions, such as loss of power to the main pumps, and provides an emergency oil supply to the turbine bearings. The subsystem typically consists of a DC motor-driven emergency bearing oil pump and check valves. Alternate system configurations may include an AC motor-driven main bearing oil pump acting as the emergency bearing oil pump and powered by the emergency battery bank through an inverter.

6. **Piping system:** The piping subsystem provides the path for the oil to flow to and from various components — for example, to the turbine bearings and back to the oil reservoir.

System Operation and Maintenance

System availability and reliability depend on the proper operation and maintenance of the system components. Key factors for ensuring a robust operation and maintenance program include:

- Routine operational testing
- Maintenance management
  - planned maintenance schedules
  - industry model practices and OEM recommendations
  - availability of replacement parts
  - safe work practices
- Operational awareness
- Operator and maintenance training
- Readily available technical documents
- Document review and management of change programs

Recommended Model Practices

System Configuration

- Each unit should have a dedicated battery bank with sufficient capacity to provide emergency power to allow a safe coast-down of the unit.
- Battery room(s) should be designed to applicable IEEE standards to ensure optimal performance.
- The system should be configured with a loss of DC power annunciator in the control room or a similar centralized location.
- The lubricating oil system should include multiple pressure-sensing switches with a voting logic to assess the system operating condition and initiate a start of the emergency bearing oil pump.
- The starting circuit for the emergency bearing oil pump motor should include normally energized relays to ensure starting reliability of the pump.
- The thermal overload for the emergency bearing oil pump motor should be configured for alarm only.

Routine Checks

- Functionally test the emergency bearing oil pumps weekly using the pressure-drop method unless directed otherwise by the OEM. Routine training should be conducted on the test procedure. Although beneficial, emergency oil pump starting as part of the startup sequence is not a substitute for a functional test.
- Emergency battery banks should be maintained and capacity-tested in accordance with the applicable IEEE standards to ensure sufficient capacity and operational readiness.
- Review alarm logs during assigned shifts and address unusual parameters or alarms to ensure timely troubleshooting.
- Routine oil analysis should be conducted to ensure that the oil continues to meet original design specifications.
- Ensure the functionality of lubricating oil system supervisory instrumentation such as low lube oil pressure alarms, high lube oil temperature alarms, low lube oil reservoir level alarms, etc.

Training

On-site personnel are crucial to ensuring reliable system operation. The facility should develop training programs to:

- Ensure adequate system-level knowledge and proficiency regarding critical system parameters, alarms, trip points and testing.
- Provide refresher training, including emergency drill scenarios.
- Review planned and implemented upgrades for modifications that impact lubricating oil system components.
- Conduct an incident review following a system malfunction.

Record Keeping

Finally, the importance of documentation and proper record keeping cannot be emphasized enough. This includes:

- Archiving day-to-day operating data.
- Periodic review and update of operating and maintenance procedures according to company guidelines.
- Maintaining a library of technical manuals and OEM-issued technical service bulletins.
- Appropriate change management controls to ensure that all drawings accurately reflect current configurations.
- Maintaining personnel qualification and training records.

Conclusion

Lessons learned within the power generation industry have led to significant advancements in equipment, system design and monitoring capabilities. Incorporating sound lubricating oil system inspection, maintenance, testing, training and record-keeping practices is critical to avoid preventable catastrophic failures and resulting losses.

References

OEM guidelines were used in the compilation of this document. Although OEM reference documents generally apply to specific steam and combustion turbines, the principles are applicable to most types of turbine generators. For questions regarding the applicability of OEM and non-OEM documents, contact the OEM for unit-specific guidance.

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